

establish or maintain voice communications.

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#### § 87.139 Emission limitations.

(a) Except for ELTs and when using single sideband (R3E, H3E, J3E), or frequency modulation (F9) or digital modulation (F9Y) for telemetry or telecommand in the frequency bands 1435–1535 MHz and 2310–2390 MHz or digital modulation (G7D) for differential GPS, the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth the attenuation for aircraft station transmitters must be at least 40 dB; and the attenuation for aeronautical station transmitters must be at least  $43 + 10 \log_{10} \text{pY dB}$ .

(b) For aircraft station transmitters and for aeronautical station transmitters first installed before February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the mean power of any emissions must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 25 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 4.0 kHz, the attenuation must be at least 35 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 4.0 kHz for aircraft station transmitters the attenuation must be at least 40 dB; and for aeronautical station transmitters the attenuation must be at least  $43 + 10 \log_{10} \text{pY dB}$ .

(c) For aircraft station transmitters first installed after February 1, 1983, and for aeronautical station transmitters in use after February 1, 1983, and using H2B, H3E, J3E, J7B or J9W, the peak envelope power of any emissions must be attenuated below the peak envelope power of the transmitter (pX) as follows:

(1) When the frequency is removed from the assigned frequency by more than 50 percent up to and including 150 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 30 dB.

(2) When the frequency is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth of 3.0 kHz, the attenuation must be at least 38 dB.

(3) When the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth of 3.0 kHz for aircraft transmitters the attenuation must be at least 43 dB. For aeronautical station transmitters with transmitter power up to and including 50 watts the attenuation must be at least  $43 + 10 \log_{10} \text{pX dB}$  and with transmitter power more than 50 watts the attenuation must be at least 60 dB.

(d) Except for telemetry in the 1435–1535 MHz band, when the frequency is removed from the assigned frequency by more than 250 percent of the authorized bandwidth for aircraft stations above 30 MHz and all ground stations the attenuation must be at least  $43 + 10 \log_{10} \text{pY dB}$ .

(e) When using frequency modulation or digital modulation for telemetry or telecommand in the 1435–1535 MHz and 2310–2390 MHz frequency bands with an authorized bandwidth equal to or less than 1 MHz the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than

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100 percent of the authorized bandwidth up to and including 100 percent plus 0.5 MHz, the attenuation must be at least 60 dB, when measured in a 3.0 kHz bandwidth. This signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 100 percent of the authorized bandwidth plus 0.5 MHz, the attenuation must be at least  $55 + 10 \log_{10} pY$  dB when measured in a 3.0 kHz bandwidth.

(f) When using frequency modulation or digital modulation for telemetry or telecommand in the 1435–1535 MHz or 2310–2390 MHz frequency bands with an authorized bandwidth greater than 1 MHz, the emissions must be attenuated as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 0.5 MHz up to and including 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be 60 dB, when measured in a 3.0 kHz bandwidth. The signal need not be attenuated more than 25 dB below 1 milliwatt.

(2) On any frequency removed from the assigned frequency by more than 50 percent of the authorized bandwidth plus 1.0 MHz, the attenuation must be at least  $55 + 10 \log_{10} pY$  dB, when measured in a 3.0 kHz bandwidth.

(g) The requirements of paragraphs (e) and (f) of this section apply to transmitters approved after January 1, 1977, and to all transmitters first installed after January 1, 1983.

(h) For ELTs operating on 121.500 MHz, 243.000 MHz and 406.025 MHz the mean power of any emission must be attenuated below the mean power of the transmitter (pY) as follows:

(1) When the frequency is moved from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth the attenuation must be at least 25 dB;

(2) When the frequency is removed from the assigned frequency by more than 100 percent of the authorized bandwidth the attenuation must be at least 30 dB.

(i) In case of conflict with other provisions of § 87.139, the provisions of this paragraph shall govern for aircraft earth stations. When using G1D, G1E,

or G1W emissions in the 1646.5–1660.5 MHz frequency band, the emissions must be attenuated as shown below.

(1) At rated output power, while transmitting a modulated single carrier, the composite spurious and noise output shall be attenuated below the mean power of the transmitter, pY, by at least:

Frequency (MHz)	Attenuation (dB) <sup>1</sup>
.005–1559	83 or $(65 + 10 \log_{10} pY)$ , whichever is greater.
1559–18000	55 or $(37 + 10 \log_{10} pY)$ <sup>2</sup> , whichever is greater.

<sup>1</sup> These values are expressed in dB below the carrier referenced to a 4 kHz bandwidth and relative to the maximum emission envelope level.

<sup>2</sup> Excluding the frequency band of  $\pm 35$  kHz or  $\pm 4.00 \times$  the symbol rate (SR), about the carrier frequency, whichever is the greater exclusion.

(2) For transmitters rated at 60 watts or less:

When transmitting two unmodulated carriers, each 3 dB below the rated power, the mean power of any intermodulation products must be at least 24 dB below the mean power of either carrier.

(3) The transmitter emission limit is a function of the modulation type and symbol rate (SR). Symbol Rate is expressed in symbols per second.

(4) While transmitting a single modulated signal at the rated output power of the transmitter, the emissions must be attenuated below the maximum emission level by at least:

Frequency Offset (normalized to SR)	Attenuation (dB)
$\pm 0.75 \times SR$ .....	0
$\pm 1.40 \times SR$ .....	20
$\pm 2.80 \times SR$ .....	40
$\pm 4.00 \times SR$ or $\pm 35$ kHz .....	$F_m$
Whichever is greater.	

Where:

$F_m = 55$  or  $(37 + 10 \log_{10} pY)$ , whichever is greater

SR = Symbol Rate

SR = 1 x channel rate for BPSK

SR = 0.5 x channel rate for QPSK

The mask shall be defined by drawing straight lines through the above points.

(j) When using G7D for differential GPS in the 112–118 MHz band, the amount of power during transmission under all operating conditions when measured over a 25 kHz bandwidth centered on either of the second adjacent

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channels shall not exceed  $-25$  dBm and shall decrease 5 dB per octave until  $-52$  dBm.

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### § 87.141 Modulation requirements.

(a) When A3E emission is used, the modulation percentage must not exceed 100 percent. This requirement does not apply to emergency locator transmitters or survival craft transmitters.

(b) A double sideband full carrier amplitude modulated radiotelephone transmitter with rated carrier power output exceeding 10 watts must be capable of automatically preventing modulation in excess of 100 percent.

(c) If any licensed radiotelephone transmitter causes harmful interference to any authorized radio service because of excessive modulation, the Commission will require the use of the transmitter to be discontinued until it is rendered capable of automatically preventing modulation in excess of 100 percent.

(d) Single sideband transmitters must be able to operate in the following modes:

Carrier mode	Level N(dB) of the carrier with respect to peak envelope power
Full carrier (H3E) .....	$O > N > -6$ .
Suppressed carrier (J3E) .....	Aircraft stations $N < -26 \geq$ Aeronautical stations $N < -40$ .

(e) Each frequency modulated transmitter operating in the band 72.0–76.0 MHz must have a modulation limiter.

(f) Each frequency modulated transmitter equipped with a modulation limiter must have a low pass filter between the modulation limiter and the modulated stage. At audio frequencies between 3 kHz and 15 kHz, the filter must have an attenuation greater than the attenuation at 1 kHz by at least 40  $\log_{10}(f/3)$  db where “f” is the frequency in kilohertz. Above 15 kHz, the attenuation must be at least 28 db greater than the attenuation at 1 kHz.

(g) Except that symmetric side bands are not required, the modulation characteristics for ELTs must be in accord-

ance with specifications contained in the Federal Aviation Administration (FAA) Technical Standard Order (TSO) Document TSO-C91a titled “Emergency Locator Transmitter (ELT) Equipment” dated April 29, 1985. TSO-C91a is incorporated by reference in accordance with 5 U.S.C. 552(a). TSO-C91a may be obtained from the Department of Transportation, Federal Aviation Administration, Office of Airworthiness, 800 Independence Avenue SW., Washington DC 20591.

(h) ELTs must use A3X emission and may use A3E or NON emissions on an optional basis while transmitting. Each transmission of a synthesized or recorded voice message from an ELT must be preceded by the words “this is a recording”; transmission of A3E or NON emission must not exceed 90 seconds; and any transmission of A3E or NON emissions must be followed by at least three minutes of A3X emission.

(i) ELTs manufactured on or after October 1, 1988, must have a clearly defined carrier frequency distinct from the modulation sidebands for the mandatory emission, A3X, and, if used, the A3E or NON emissions. On 121.500 MHz at least thirty per cent of the total power emitted during any transmission cycle with or without modulation must be contained within plus or minus 30 Hz of the carrier frequency. On 243.000 MHz at least thirty percent of the total power emitted during any transmission cycle with or without modulation must be contained within plus or minus 60 Hz of the carrier frequency. Additionally, if the type of emission is changed during transmission, the carrier frequency must not shift more than plus or minus 30 Hz on 121.500 MHz and not more than plus or minus 60 Hz on 243.000 MHz. The long term stability of the carrier frequency must comply with the requirements in § 87.133 of this part.

(j) Transmitters used at Aircraft earth stations must employ BPSK for transmission rates up to and including 2400 bits per second, and QPSK for higher rates.

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